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THREE-DIMENSIONALLY SHAPED FLAT PLANAR CABLE, METHOD FOR PRODUCTION AND USE THEREOF

Description

[0001] The present invention relates to a three-dimensionally (3D) shaped flat cable, method for its manufacture and use thereof.

[0002] A method for manufacturing a cable harness for vehicles is known from German Patent Application 196 49 972, in which the cables are bonded using a support sheet, provided with plug connectors, and attached to a dimensionally stable substrate. At least some of the cables are non-insulated bunched conductors which, successively and independently from one another, are applied along a predefined track to an insulating support sheet which is provided with an adhesive layer and either an insulating protective sheet is subsequently applied to the support sheet and bonded under pressure with the support sheet, or the support sheet and the applied bunched conductors are coated with a layer of protective lacquer and finally adapted to the contour of the place of installation via trimming. The labor-intensive placing of the conductor tracks and their attachment to the dimensionally stable substrate are disadvantages in this method.

[0003] A cable harness and a method for its manufacture are known from German Patent Application 196 28 850. The cable harness has electric cables which are situated in a first resin layer having recesses, the first resin layer being formed in such a way that it runs along a predefined installation track of the electric cables and a second resin layer is fixedly connected to the first resin layer in such a way that it covers at least the recess of the first resin layer and is applied via vacuum forming.

[0004] The known approaches have the disadvantage that either the cables must be applied to the surface of the dimensionally stable substrate by hand in a very labor-intensive process, or separate parts must be manufactured, the conductors introduced and fixed in their position using

the second resin.

[0005] The object of the present invention is to provide a three-dimensionally shaped flat cable and a method for its manufacture which avoids the disadvantages of the known approaches and which allows in the intermediate step the manufacture of dimensionally stable flat cables which are only placed in their place of installation in a second step.

[0006] According to the present invention, the object is achieved by a flat cable made of a laminate which includes at least one conductor track enclosed between two insulation layers, and at least one support layer, which are connected to one another via an adhesive layer, the laminate being applied to a positive die and shaped by applying heat and pressure and fixed in its three-dimensional shape by cooling to below glass temperature T_g of the adhesive layer or by hardening the adhesive layer. Such a 3D flat cable is also storable as an intermediate part prior to installation. The support layer may be made of metal foils, plastic sheets, or porous layers.

[0007] A thermoplastic adhesive, a thermoplastic adhesive foil and/or an adhesive-bonded nonwoven having a melting point T_m of <180°C and/or a latent reactive adhesive having a cross-linking temperature of <140°C is/are preferably used as the adhesive layer. Adhesive layers of this type make it possible to fixedly bond the flat cable layer to the support layer and to shape them into an intermediate molded part. Cross-linking temperatures of >140°C may also be used when damage is impossible due to cooling of the conductor track layer. Cooling may be omitted when reactive adhesives are used; however, appropriate strengthening must have occurred in this case via extensive hardening by cross-linking.

[0008] Moreover, another porous layer for covering may be provided for better handling. The porous layer is advantageously made of a nonwoven or a fabric of polymer fibers.

[0009] The flat cable according to the present invention may at least partially be back-coated using a thermoplast. This makes it possible to manufacture parts shaped in the place of installation.

[0010] The conductors of the conductor track are advantageously exposed at least in partial sections of their surface prior to lamination for forming contact fields.

[0011] Particularly preferred is a flat cable which is fitted with electronic components. This makes it possible to manufacture operationally ready-for-use electronic built-in components in a very economical manner.

[0012] Manufacturing of the 3D flat cables as intermediate parts takes place in such a way that the laminate composed of flat cable, adhesive, and nonwoven layers is applied to a positive die, adjusted, and shaped by applying heat and/or radiation and/or pressure and fixed in its shape by cooling to below the glass transition temperature T_g of the adhesive layer or by hardening the adhesive layer. A partial vacuum is applied to the backside of the laminate as the pressure, for example.

[0013] The laminate parts, fixed in shape, are preferably remachined by stamping, milling, or cutting and are, in a separate step, installed in their place of installation or are, for better assembly, at least partially back-coated in an injection molding process using a thermoplast.

[0014] For equalizing the temperature, a metal foil is preferably used during the laminating process and/or in the die.

[0015] Nonwovens made of polyester or polyamide which have a thickness of 0.1 mm to 2 mm, a tensile strength of 50 to 250 N/50 mm, and an elongation of 30% to 50% are preferably used for the aforementioned method. The adhesive nonwoven used as the thermoplastic adhesive layer should have a softening point between 30°C and 180°C, its mass per unit area should be between 10 g/m^2 and 70 g/m^2, and it should have a low melt index.

[0016] The present invention is subsequently explained in greater detail based on the examples.

[0017] Example 1

[0018] Flexible flat cables (FFC), 1.2 mm to 1.4 mm thick, spunbonded nonwoven made of copolyamides having a T_m of 105°C to 110°C and a mass per unit area of 30 g/m^2, and adhesive-bonded nonwoven made of polyethylene terephthalate having a mass per unit area of 250 g/m^2 are used as material. Using a melting adhesive, a nonwoven is laminated onto the backside of an FFC at 140°C with the aid of an ironing press. The nonwoven is used as the support layer and the melting adhesive improves the formability. This laminate is fixed on a positive die and is shaped at 140°C/30 s. After the tool has cooled down, the laminate is removed from the mold as a dimensionally stable flat cable.

[0019] Example 2

[0020] As in example 1, a flexible flat cable including 45 g/m^2 of a copolyamide having a melting point T_m of 105°C and an adhesive-bonded staple fiber nonwoven made of polyethylene terephthalate fibers having a mass per unit area of 100 g/m^2 are laminated together using a 0.5 mm thick aluminum foil as a cooling element and fixed on a positive die at 140°C/45 s. After the tool has cooled down, the laminate is removed from the mold as a dimensionally stable flat cable.

[0021] Example 3

[0022] As in example 1, a flexible flat cable including an ultraviolet light (UV)-hardening adhesive and an adhesive-bonded nonwoven made of polyethylene terephthalate fibers having a mass per unit area of 150 g/m^2 are laminated together. Shaping takes place on a positive die at room temperature under UV light irradiation. After hardening, the laminate is removed from the mold as a dimensionally stable flat cable. The dimensionally stable flat cable is subsequently partially back-coated in an injection molding process using polypropylene.

[0023] Example 4

[0024] As in example 1, a flexible flat cable, which is fitted with electronic components such as light-emitting diodes (LED), including 25 g/m^2 of a copolyamide having a melting point T_m of

105°C and an adhesive-bonded nonwoven made of polyethylene terephthalate fibers having a mass per unit area of 150 g/m^2 are laminated together and fixed on a positive die at 110°C/120 s. After the tool has cooled down, the laminate is removed from the mold as a dimensionally stable flat cable.

[0025] Additional examples are shown in the following tables.

Example	5	6	7	8	9
FFC	PET/Cu	PET/Cu	PET/Cu	PET/Cu	PET/Cu
Adhesive	Copolyamide Tm 105°C 25 g/m^2	Copolyamide Tm 105°C 25 g/m^2	Copolyamide Tm 105°C 25 g/m^2	Copolyamide Tm 105°C 25 g/m^2	Copolyamide Tm 105°C 45 g/m^2
Support	250 g/m^2 PET Nonwoven heat-bonded	250 g/m^2 PET Nonwoven heat-bonded	250 g/m^2 PET Nonwoven chemically bonded	250 g/m^2 PET Nonwoven chemically bonded	100 g/m^2 PET Staple fiber nonwoven heat-bonded
Laminating temperature	130°C	130°C	130°C	130°C	120°C
Aluminum	no	yes	no	yes	no
Shaping temperature/time	140°C/30 s	160°C/60 s	160°C/60 s	160°C/30 s	115°C/120 s
Pressure	yes	yes	yes	yes	yes

Example	10	11	12	13	14
FFC	PET/Cu	PET/Cu	PEN/Cu	PET/Cu/LEDs	PI/Cu
Adhesive	Copolyamide Tm 105°C 15 g/m^2	EVA Tm 80°C	UV Cross-linking system	Copolyamide Tm 105°C 25 g/m^2	25 g/m^2 Epoxide/ Copolyamide
Support	100 g/m^2 Nonwoven glass fiber	PP 15 g/m^2 Staple fiber nonwoven heat-bonded	150 g/m^2 PET Nonwoven heat-bonded	150 g/m^2 PET Nonwoven heat-bonded	130 g/m^2 PET/PA Nonwoven water jet bonded
Laminating temperature	120°C	95°C	RT	110°C	120°C
Aluminum	no	no	no	no	no
Shaping temperature/time	145°C/120 s	110°C/180 s	Room temperature	120°C/120 s	180°C/10 s
Pressure	yes	yes	yes	yes	no

Example	15	16	17	18
FFC	PEN/Cu	PEN/Cu	PEN/Cu	PEN/Cu
Adhesive	Copolyamide Tm 105°C 500 g/m^2	Copolyamide sheet (Texiron 199 protechnic) Tm 105°C 450 g/m^2	Copolyamide sheet (Texiron 199 protechnic) Tm 105°C 450 g/m^2	Copolyester Tm 115°C Hotmelt 450 g/m^2
Support	250 g/m^2 PET Nonwoven heat-bonded	180 µm Aluminum foil	180 µm PET sheet	250 g/m^2 PET Nonwoven chemically bonded

Laminating temperature	140°C	140°C	140°C	140°C
Aluminum	no	yes	no	no
Shaping temperature/time	140°C/300 s	140°C/60 s	140°C/60 s	140°C/60 s
Pressure	yes	yes	yes	yes